

**IN THE UNITED STATES PATENT AND TRADEMARK OFFICE  
BEFORE THE BOARD OF PATENT APPEALS AND INTERFERENCES**

Applicant(s): Michael M. Iwatake (et al.)      Examiner: Anh D. Mai  
Serial No.: 10/711,298      Group Art Unit: 2814  
Filed: September 9, 2004      Attorney Docket No: FIS920040156  
Title: VIA CONTACT STRUCTURE HAVING DUAL SILICIDE LAYERS

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Mail Stop Reply Brief  
Commissioner for Patents  
P.O. Box 1450  
Alexandria, VA 22313-1450

**REPLY BRIEF**

Sir:

This paper is submitted in response to an Examiner's Answer mailed December 7, 2006 by the United States Patent and Trademark Office in connection with an Appeal Brief filed September 6, 2006 by Appellants for the above-identified Application. According to 37 CFR 41.41(a)(1), a Reply Brief to this Examiner's Answer may be filed by February 7, 2007. Therefore, this Reply Brief is being timely filed.

This Reply Brief contains items under the following headings and in the order set forth below, as required under 37 C.F.R. § 41.37:

- I. Real party in interest
- II. Related appeals and interferences
- III. Status of claims
- IV. Status of amendments
- V. Summary of claimed subject matter

- VI. Grounds of rejection to be reviewed on appeal
- VII. Arguments
- VIII. Claims appendix
- IX. Evidence appendix
- X. Related proceedings appendix

**I. Related party in interest**

International Business Machines Corporation is the real party in interest in this appeal.

**II. Related appeals and interferences**

There are no related appeals or interferences that will directly affect, or be directly affected by, or have a bearing on the Board's decision in this appeal.

**III. Status of claims**

The claims in the Application are: Claims 1-10, totaling 10 claims.

Claims 1-10 are rejected.

Claims 1-10 are on appeal pursuant to Notice of Appeal filed on July 7, 2006.

**IV. Status of amendments**

No amendments were made following the Final Office Action mailed on April 13, 2006.

Appellants made a response, on May 30, 2006, to the Final Office Action and amended the title of the application to more particularly descriptive of the present invention. However, no amendments were made to the claims currently under appeal.

**V. Summary of claimed subject matter**

The claimed invention relates to a via contact structure (e.g., FIG. 1) having a via contact (e.g., 100 of FIG. 1) to a diffusion region (e.g., 102 of FIG. 1) at a top surface (e.g., 101 of FIG. 1) of a substrate. The via contact structure includes 1) a first layer (e.g., 103 of FIG. 1) consisting essentially of a silicide of a first metal in contact with the diffusion region at the top surface (p.8, lines 14-15); 2) a dielectric region (e.g., 112 of FIG. 1) overlying the first layer (p.8, lines 13-14), the dielectric region having an outer

surface (e.g., 120 of FIG. 1) and an opening (e.g., 110 of FIGS. 1&4) extending from the outer surface through the first layer to the top surface (FIGS. 1&4, p.8, lines 9-12) of the substrate; 3) a second layer (e.g., 106 of FIGS. 1&5-7) lining the opening and contacting the top surface in the opening (p.14, lines 19-20), the second layer including a second metal lining a sidewall of the opening (p.14, lines 19-20) and a silicide of the second metal self-aligned to the top surface in the opening (p.17, lines 4-5); 4) a diffusion barrier layer (e.g., 122 of FIGS. 1&6-7) overlying the second layer within the opening (p.16, lines 1-2); and 5) a third layer (e.g., 124 of FIGS. 1&7) including a third metal overlying the diffusion barrier layer and filling the opening (p.16, lines 12-14).

#### **VI. Grounds of rejection to be reviewed on appeal**

The issues presented in this appeal are:

whether claims 1-5 and 8 are anticipated by Chung et al. (US. 5,094,981);

whether claims 6, 7, 9 and 10 are obvious over Chung et al. in view of Ohsaki (JP. Patent No. 08-107087); and

whether claims 4 and 5 are indefinite.

#### **VII. Arguments**

In the Final Office Action of April 13, 2006, the Examiner erroneously rejected claims 1-5 and 8 under 35 U.S.C. §102(b), as being anticipated by Chung et al. (US 5,094,981) (“Chung”).

In rejecting claim 1, the Examiner alleges that Chung describes a via contact structure having a first layer (42c) and a dielectric region (32) overlying the first layer, with the dielectric region (32) having an outer surface and an opening. However, failing to assert that Chung teaches the opening extending from the outer surface “through said first layer to said top surface of said substrate”, which is specifically required by claim 1 of the instant application, the Examiner contends that the claim element of “an opening extending from said outer surface through said first layer to said top surface of said

substrate” (the “expression”) is a product-by-process limitation and therefore is not given patentable weight.

Appellants’ arguments are as follows:

Appellants find that the Examiner’s allegation that the “expression” is a product-by-process limitation is hard to comprehend. The “expression” clearly describes how a final structure of the present invention, according to one embodiment, may look like. That is, the final structure of the present invention may have an opening, which is part of the structure and is described by the “expression”, wherein a via contact, according to one embodiment of the present invention, is formed. Appellants assert that in no way may the “expression” be interpreted as describing a process or a method of making the opening, or a process or a method of making the structure of the present invention.

In the Examiner’s Answer of December 7, 2006, the Examiner maintained the position that the “expression” (“an opening extending from said outer surface through said first layer to said top surface of said substrate”) is a product-by-process limitation. The Examiner’s argument is that the final structure shown in FIG. 1 does not have any opening at all, stating that “what ever was formed previously, during the process, had been filled by the contact materials” (page 10, lines below FIG. 1).

Appellants’ arguments are as follows:

By alleging that the final structure shown in FIG. 1 does not have any opening at all (because “what ever was formed previously, during the process, had been filled by the contact materials”), the Examiner clearly contradicts with the Examiner’s own argument presented in both the Final Office Action and in the Examiner’s Answer in rejecting claim 1 of the instant application.

In the Examiner’s Answer (and the Final Office Action), the Examiner states:

With respect to claim 1, Chung teaches a via contact structure having a via contact to a diffusion region (18) at a top surface of a substrate (10) as claimed, the via contact structure includes:

a first layer (42c) consisting essentially of a silicide of a first metal in contact with the diffusion region (18) at the top surface;

a dielectric region (32) overlying the first layer (42c), the dielectric region (32) having an outer surface and an opening extending from the outer surface of the dielectric region (32);

a second layer (34) lining the opening and contacting the top surface in the opening, the second layer (34) including a second metal lining a sidewall of the opening and a silicide of the second metal self-aligned to the top surface in the opening;

a diffusion barrier layer (36) overlying the second layer (34) within the opening; and

a third layer (40c) including a third metal overlying the diffusion barrier layer (36) and filling the opening. (Emphasis added).

By presenting the argument as quoted above, the Examiner is clearly using the term “opening” to describe a structure (FIG. 2d of Chung) and so to allege that the structure of claim 1 is anticipated. The Examiner has effectively acknowledged that the “expression” (“an opening extending from said outer surface through said first layer to said top surface of said substrate”, which is a distinctive element of claim 1), is a description of a structure and not a description of a process step.

Otherwise, according to the Examiner’s own argument for the alleged product-by-process limitation, FIG. 2d of Chung will be deemed to have NOT disclosed an opening because what ever was formed previously in dielectric region (32) had been filled with “second layer 34”, “diffusion barrier layer 36”, and “third layer 40c”. In other words, the structure shown in FIG. 2d of Chung does not have any openings at all. Thus, according to the Examiner’s argument for the alleged product-by-process limitation, the Examiner’s argument as quoted above for rejecting claim 1 of the instant application is invalid.

Furthermore, Appellants find it hard to comprehend that an opening will become non-existence simply because it is filled with something other than air. Appellants have not been able to find, and the Examiner has not provided, a definition available from any authoritative source defining that an opening is an opening only when it is empty or filled with air. In fact, it is generally understood by a person skilled in the art that an opening may also refer to a portion of a region wherein the original material of the region in that portion is removed, whether it be refilled with another kind of material or not.

Building on the above allegation that the “expression” is a product-by-process limitation and therefore not given patent weight, the Examiner then contends that Chung describes a second layer lining the opening and contacting the top surface (of the substrate) in the opening, even though the Examiner has failed to show that Chung discloses an opening that extends to the top surface of the substrate. As is clearly shown in FIG. 2d which is specifically cited by the Examiner, the opening of dielectric region (32) does not even extend through layer (42c) to the top surface of substrate (10). Therefore, it is technically impossible for liner (34) to contact the top surface of substrate (10) in the opening of dielectric region (32).

In the Examiner’s Answer, the Examiner states that Chung teaches “thin titanium silicon layers, not shown in the drawings, may form along the interfaces between Ti layer 34 and silicide layers 42A-42C during the RTA”. Based on this, the Examiner allegedly concludes that since a portion of layer 34 forms a silicide layer at the interface with another silicide layer 42c, these layers (34, 42c and the silicon layer) became one layer, and thus layer 34 is in contact with the substrate.

Appellants’ arguments are as follows:

By alleging that layer 34, 42c and those thin titanium silicon layers (which may form during an RTA) became one layer, the Examiner contradicts with the Examiner’s own argument presented in rejecting claim 1 of the instant application.

In rejecting claim 1 of the instant application, the Examiner contends that Chung teaches “a first layer (42c) consisting essentially of a silicide of a first metal...”, and “a second layer (34) lining the opening and contacting the top surface in the opening...” (Pages 4-5, Examiner’s Answer) In other words, the Examiner clearly acknowledges that layer 42c and layer 34 are distinct and different layers. By later stating that layer 42c and layer 34 becomes one layer, the Examiner is in direct contradiction with an earlier allegation (that the final structure of Chung has two different layers 42c and 34) used to allege that the structure claimed by claim 1 of the instant application is anticipated.

Appellants have not been able to find a clear definition, even from the argument presented by the Examiner, as to when multiple different layers may be considered as a single layer and when they cannot. In particular, Appellants respectfully submit that it is

difficult for a person skilled in the art to comprehend that layer 42c (particularly with portions of layer 42c underneath dielectric region 32) and layer 34 may be considered, even remotely, as a single layer.

In the Office Action, the Examiner erroneously rejected claims 2-10 as either anticipated by or obvious over prior art references of record. The fact is that claims 2-10 depend directly or indirectly from claim 1, and thus are patentable at least for the reasons as described above with regard to claim 1.

In the Examiner's Answer, the Examiner alleges that since claim 1 is anticipated, claims 2-10 are either anticipated by Chung or made obvious by Chung and Osaki.

Appellants respectfully submit that even if claim 1 is anticipated by Chung, which is clearly not true as being discussed above in detail, this does not automatically render claims 2-10 being anticipated or obvious since claims 2-10 clearly contains their own distinctive features and elements other than those already cited in independent claim 1.

In the Office Action, the Examiner erroneously rejected claims 4 and 5 under 35 U.S.C. §112, second paragraph, as being indefinite. The Examiner alleges that the first metal is a silicide and the sidewall portion of the second metal is a metal and therefore they are not the same. The Examiner also alleges that because the first metal and the bottom portion of the second metal are silicide, they do not consist of essentially cobalt or titanium.

Appellants' arguments are as follows:

The Examiner's statements that "the first metal is a silicide" and "the first metal and the bottom portion of the second metal are silicide" are technically incorrect. The fact is that a metal does not equal to a silicide and is different from a silicide.

On the other hand, a silicide may comprise of one or more metal elements. For example, if titanium is used in forming a silicide, the silicide formed may be known as titanium silicide (TiSi). Similarly, if cobalt is used in forming a silicide, the formed silicide may be known as cobalt silicide (CoSi). A person skilled in the art will appreciate



that a first metal or a first metal forming a first silicide may be the same (for example, if both are cobalt) or different (for example, if one is titanium and the other is cobalt) from a second metal or a second metal forming a second silicide.

Claims 4 and 5 depend from claim 1, therefore the first metal (that forms the silicide of the first layer) and the second metal (that forms a sidewall portion and the silicide of a bottom portion of the second layer) may be the same. In addition, the first and/or second metal may consist essentially of cobalt, titanium, or any other metals. Appellants respectfully submit that it is hard for a person of ordinary skill to comprehend any reasons why the first and second metals can not be the same or can not consist essentially of cobalt, titanium, or any other metals.

In the Examiner's Answer, the Examiner made a new ground of rejection by contending that Appellants admit in a paper filed on April 6, 2006, that first metal and second metal refer to different and therefore are not the same. Appellants disagree and respectfully submit that Appellants' arguments presented in the April 6, 2006 paper were taken out of the context.

In the paper of April 6, 2006, in an effect to correct a misinterpretation made by the Examiner that both first metal and second metal refer to the same metal 106, Appellants stated that first metal refers to metal element in layer 103 and second metal refers to metal element in layer 106. Under this context, Appellants paraphrased (in other words) that "first metal and second metal" refers to different metal elements, which clearly means that first metal and second metal refers to metal elements in different layers (layer 103 and layer 106) and not in the same layer 106 (as interpreted by the Examiner). Appellants's intention of argument is further clarified by a follow-up statement which reads "as opposed to same metal 106 as alleged by the Examiner".

In view of above statement, it is respectfully submitted that Appellants have never admitted that first metal and second metal are different metal elements, but rather they are metal elements in different layers. Appellants respectfully request that the current appeal be maintained.

## **VIII. Claims appendix**

The text of claims 1-10 involved in this Appeal are:

1. A via contact structure having a via contact to a diffusion region at a top surface of a substrate, the via contact structure comprising:

a first layer consisting essentially of a silicide of a first metal in contact with said diffusion region at said top surface;

a dielectric region overlying said first layer, said dielectric region having an outer surface and an opening extending from said outer surface through said first layer to said top surface of said substrate;

a second layer lining said opening and contacting said top surface in said opening, said second layer including a second metal lining a sidewall of said opening and a silicide of said second metal self-aligned to said top surface in said opening;

a diffusion barrier layer overlying said second layer within said opening; and

a third layer including a third metal overlying said diffusion barrier layer and filling said opening.

2. The via contact structure as claimed in claim 1, wherein said first metal is selected from the group consisting of cobalt (Co), molybdenum (Mo), niobium (Nb), nickel (Ni), palladium (Pd), platinum (Pt), tantalum (Ta), titanium (Ti), vanadium (V) and tungsten (W).

3. The via contact structure as claimed in claim 2, wherein said second metal is selected from the group consisting of titanium (Ti), nickel (Ni), platinum (Pt), cobalt (Co), tantalum (Ta), and tungsten (W).

4. The via contact structure as claimed in claim 3, wherein said first metal and said second metal are the same.

5. The via contact structure as claimed in claim 3, wherein said first metal consists essentially of cobalt and said second metal consists essentially of titanium.

6. The via contact structure as claimed in claim 1, wherein said diffusion barrier layer includes a metal nitride.

7. The via contact structure as claimed in claim 6, wherein said metal nitride includes titanium nitride (TiN).

8. The via contact structure as claimed in claim 1, wherein said third metal includes tungsten (W).

9. The via contact structure as claimed in claim 1, wherein said opening has a width of about 250 nm or less and a height-to-width aspect ratio greater than one.

10. The via contact structure as claimed in claim 9, wherein said aspect ratio value is about two.

**IX. Evidence appendix**

No evidence was submitted pursuant 37 C.F.R. § 1.130, 1.131, or 1.132, and no evidence was entered separately by the Examiner.

**X. Related proceedings appendix**

None

No fees are believed to be due in connection with this paper. However if there are any such fees due, please charge any such fees to the deposit account 09-0458.

Respectfully submitted,



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